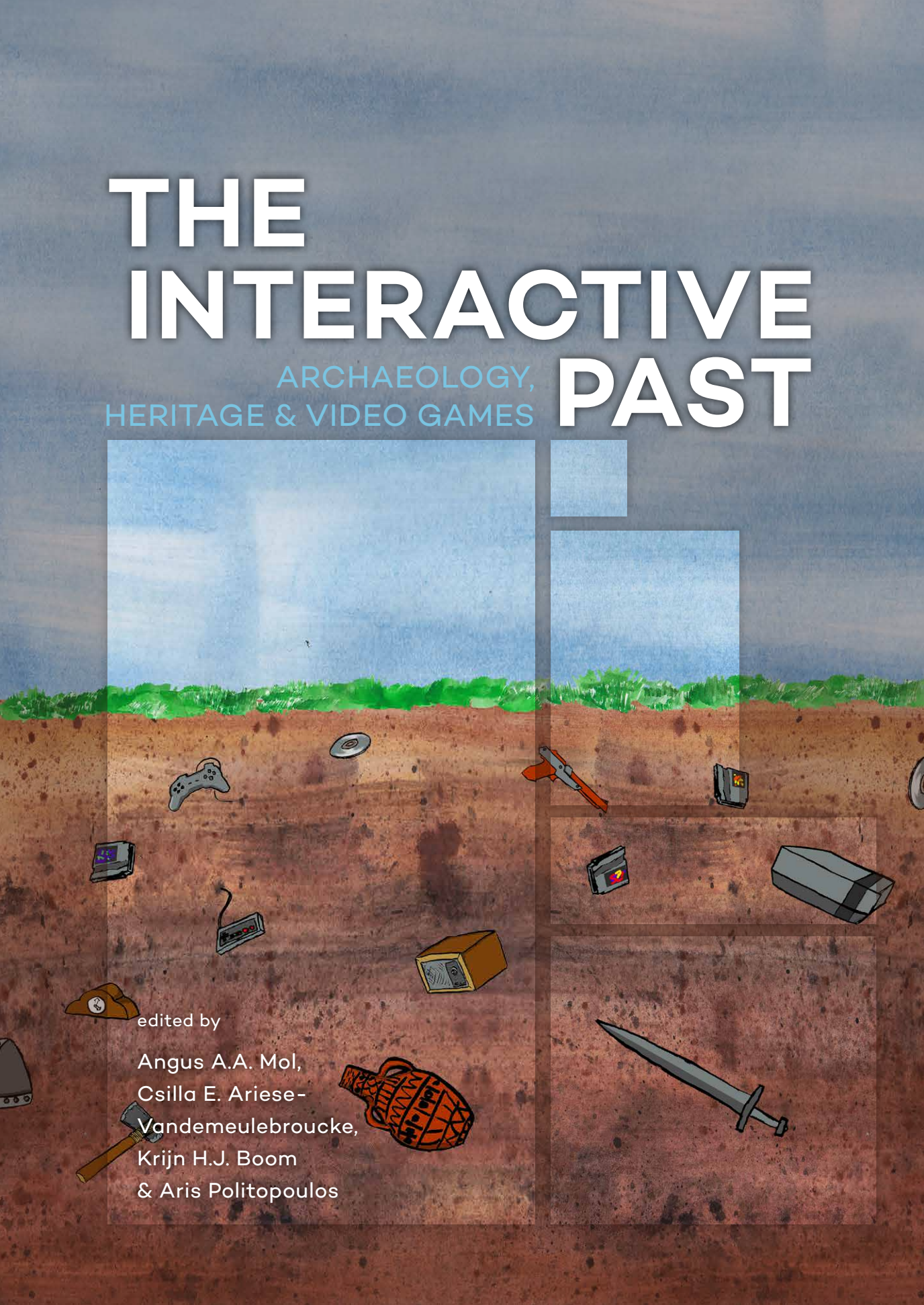
Explaining archaeological research with videogames

THE INTERACTIVE PAST

ARCHAEOLOGY, HERITAGE & VIDEO GAMES



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Introduction

Archaeology has seen a large number of digital innovations during recent decades. Geographical Information Systems, archaeometry, or laser scanning are only some of the methodological advances of the discipline. However, the public image of how archaeology works is roughly the same as it was several years ago. Public fascination with archaeology is built upon a sense of discovery. Fictional works such as *Indiana Jones*, the *Tomb Raider* series (Core Design & Crystal Dynamics 1996-2016) or *Uncharted* series (Naughty Dog 2007-2016) are based on the concept of solving a mystery by unearthing an artefact or a city that has been forgotten for centuries (Meyers Emery & Reinhard 2015). Non-fiction but still popular media producers, such as *Time Team* or *National Geographic*, also promote this sense of wonder while emphasizing the rigorous methodology of archaeological research – as distant from these fictional pillagers as can be imagined.

These efforts for the dissemination of knowledge about archaeological practice are mostly focused on fieldwork. A simple search of images on the internet reveals that archaeological research is portrayed as excavations, surveys, and spectacular sites. Fieldwork is essential for contemporary archaeology, but the types of activities linked to the exploration of the past are much more diverse, ranging from remote sensing to laboratory work or Geographic Information Systems (Renfrew & Bahn 2011: 12-18). More importantly, the use of quantitative methods allow us to test hypotheses against evidence, and for this reason scientific thinking is at the core of all contemporary archaeology. However, how much of these other archaeological

scientific practices are presented to the public? Can we exploit this fascination with discovery while explaining what archaeology is really about?

We argue here that video games can promote scientific thinking while keeping the sense of discovery used in public archaeological outreach. A video game is essentially an interactive narrative device guided by the player's attempts to face the challenges posed by game mechanics. Every time a puzzle is solved or a decision is made the story advances, thus fostering an experience of discovery. At the same time, the emphasis on problem solving is based on trial-and-error mechanisms that can be linked to the scientific method through content knowledge, process skills, and logic reasoning (Morris *et al.* 2013).

In this chapter we discuss *Evolving Planet* (Murphy's Toast Games 2016), a video game created to increase the visibility of archaeological sciences, and specifically the emerging field of Model-Based Archaeology. This video game was designed as a dissemination initiative by the research project SimulPast. The player takes the role of a future scientist studying the extinction of a sentient species on a distant planet. The use of science-fiction allowed us to portray topics such as evolution, technology, and cooperation while solving the mystery of the disappearance of an entire civilization. At the same time, the game mechanics are remarkably similar to the methods used in the project, and particularly to computer simulation. We explore here a diversity of challenges and decisions faced by the development team in the effort to explain our research methods while retaining the sense of discovery of fictional archaeology. This is followed by a discussion on the most challenging question of the development: how can we explain evolution? It is a highly influential concept in archaeology, but its mechanism of random mutation and selection cannot be easily transformed to an interactive experience. We will conclude by summarizing the results of the initiative and the potential of video games for conveying scientific thinking in archaeology.

Explaining Simulation in Archaeology

Model-based archaeology is arguably one of the most exciting fields in archaeological research, as the current study of the past requires "both sophisticated modeling and large-scale synthetic research that are only now becoming possible" (Kintigh *et al.* 2014). Model-based archaeology transforms research hypotheses into formal models that can potentially be tested against empirical evidence. It provides several advantages over traditional descriptive models, including the explication of assumptions, the use of non-ambiguous languages, and the exploration of links between variables (Epstein 2008).

Computer simulation is one of the most widely used types of formal models in archaeology. It allows researchers to cope with the uncertainty of archaeological data while exploring the dynamics of socio-natural systems (Costopoulos & Lake 2010). Simulation is not new in archaeology: there have been up to three generalized attempts to integrate this tool in the field in a similar manner to other disciplines (Lake 2014). Although its application is not as common as other computational tools currently used in the field, such as Geographical Information Systems, its use is spreading. It is almost a standard approach in evolutionary archaeology (Lycett 2015), while its presence is

increasing in the study of topics such as resilience to environmental change (Balbo *et al.* 2014) or taphonomic processes (Davies *et al.* 2016).

This is the context of the project *SimulPast: Simulating the Past to Understand Human Behaviour*. SimulPast is a large-scale 6-year project aimed to integrate simulation into current archaeological research (Caro *et al.* 2013). This ambitious agenda is pursued through the creation of multidisciplinary teams of archaeologists, physicists, computer scientists, and anthropologists working on particular case studies (for a general overview, Madella *et al.* 2014). Achieving impact beyond academic environments was one of the major challenges of SimulPast. As any other large-scale research project it should explain its goals, methods, and results to the rest of society. However, it was at first unclear how we could achieve this objective, considering the previous remarks about the public perception of archaeology. The idea of linking simulation to the perception of archaeological research seemed challenging for conventional knowledge dissemination approaches such as books or presentations. Instead, the project team decided to create a video game.

Educators have highlighted the learning potential of these interactive entertainment media since the beginning (Bredemeier & Greenblat 1981). However, most of these games are not designed for this goal and their integration within current formal educational frameworks is difficult (Amory *et al.* 1999; Gee 2003). In contrast, their use within non-formal education has become hugely popular. The flexibility of these contexts makes it possible to exploit the potential of video games, even if they were not designed for educational purposes. Learning is an essential process in most games because the player needs to learn about rules, objectives, and strategies in order to beat the game (Metzger & Paxton 2016; Squire 2008). This emphasis on problem solving can be complemented by stories. Video games are narrative devices that unfold a story as the player advances through the game. This combination seemed perfect for archaeological research: problem solving could be used to explore scientific methods, while the narrative would promote the required sense of discovery. Finally, it could be argued that games are essentially simulations in which the player takes the role of one component of a system (Rubio-Campillo 2013). Both games and simulation integrate concepts such as complexity, interactivity, and non-determinism; even the interactive experimentation of games is also present in simulation (Clapper 2016).

Thus, the planned SimulPast video game would combine these three components: problem solving, discovery, and simulation. The player would take the role of an archaeologist, using simulation in a virtual laboratory designed to explore the past. At the same time, the narrative of the game would be exploring concepts that were also central to SimulPast, such as human evolution, environmental change, or cooperation mechanisms.

The Fate of the Lovans

The first drafts of the game placed the events on planet Earth and sought to tell the story of a hypothetical extinction of *Homo Sapiens* from the perspective of the aliens. The approach had obvious educational benefits as the player would be playing through actual biological and cultural evolutionary episodes (e.g. out

of Africa, Neanderthal extinction, Neolithic transition). However it also posed strong limits in terms of game design, as we would be explaining a story we and the players already knew. We ultimately decided to set the game on a new planet in a distant future. The player would be a part of the discovery of an extinct species of sentient aliens. The idea was not new, as the search for extra-terrestrial intelligences has, in the popular imagination, been linked to the possibility of finding extinct sentient species. This fictional field, called Xenoarchaeology, has been depicted in several science-fiction works, including literature (*Hyperion*, 1989; *Gateway*, 1977; *Revelation Space,* 2000), movies (*Stargate*, 1994-2011; *Prometheus*, 2012), and video games (*Mass Effect* series, BioWare 2007-2012; *Star Wars Knights of the Old Republic II: The Sith Lords*, Obsidian Entertainment 2004; *No Man's Sky*, Hello Games 2016).

The science-fiction setting also had other advantages. By imagining the evolution of a humanoid species we would link it to our own history. At the same time, we would disentangle archaeological thinking from current academic debates, thus increasing the understanding of the discipline beyond particular sites, cultures, or periods. The new planet gave the team the freedom to create a unique ecosystem and illustrate it with innovative and unique artwork. We could also showcase current technological advances in archaeology by imagining how archaeologists may make use of them in 1000 years. Finally, the player would be discovering the fate of an ancient and mysterious civilization so we could tap into the sense of discovery that is so typical for fictional archaeology.

The entire plot of the game was based on a common archaeological research question: what are the reasons behind the collapse of a society (e.g. Diamond 2002; Downey *et al.* 2016; Tainter 2006)? The use of a science-fiction context where an entire species had become extinct increased the sense of mystery in the story. In this hypothetical context, xenoarchaeology would be the only science able to provide valid answers. Research questions were fully integrated into the science-fiction plot, as can be seen in its summary:

> *"It's the year 3016, and you are in charge of an archaeological expedition to the planet Kepler-1138. Your aim is to know what happened to the Lovans, humanoid aliens that became extinct for unknown reasons. You will use artificial life to replicate the story of the mysterious species. Will you develop their technology, make them experts on warfare or strengthen their cultural influence? Choose carefully your strategy to reveal the past of the Lovans, and also their future."*

The Development of *Evolving Planet*

The creation of a game, from the initial concepts to its release, is no straightforward process. We found out that this is even more complex for dissemination initiatives, as their goals and limitations are rather different than other video game projects. We were able to assemble a team of experts in the different components of game creation, including programming, audio, artwork, and contents. However, the team did not include anyone with previous experience in game development, so all the topics were carefully analysed and discussed in the group before making decisions.

Here we list the most important aspects of this process, including the technology used, the design of game mechanics, and the development of the plot. This set of topics will hopefully exemplify how a game designed for scientific outreach differs from other initiatives. It also illustrates the diversity of the decision making processes involved in game development, from purely technical choices to level design and narrative development.

Technology

One of the aims of this project was to create a product that could be accessed by as many players as possible. While use in formal educational settings was not disregarded, emphasis was placed on the individual experience of gaming as a method of non-formal education. This user-centred learning environment is completely voluntary, in contrast with a teacher-centred context (Watson *et al.* 2011). As a consequence, we sought to bring a similar level of game design and interactive engagement as the commercial products with whom it would be competing, otherwise nobody would play the game and the experiment would fail.

The project aimed for the game to be distributed through digital delivery services. In recent years, these platforms have democratized the access to both the target audience and the products. Digital distribution allows any small development team to publish software in contrast with the difficulties posed by physical retailers and conventional distribution methods. As a consequence, a large percentage of low-budget games are currently released only in digital downloadable formats (Lowthorpe *et al.* 2013).

The game would only be available for portable devices (i.e. smartphones and tablets). The release of the game both in the Google Play Store and Apple's App Store would allow us to maximize access to the game, while avoiding any delay posed by the Steam publication process. This was extremely important considering that the project had a fixed length of 2 years.

The decision to deliver multiplatform support (Android and iOS systems) was constrained by the fact that the team only had two part-time programmers. Each supported platform would mean duplicating the coding effort, as each platform supports a different programming language (Java for Android and Swift/Objective-C for iOS). Fortunately, this problem is ubiquitous to independent game development so to facilitate the task the programming community has created cross-platform development frameworks. Cocos2d-x was the final choice after careful evaluation. It is an open-source C++ platform able to generate binary files compatible with several systems including iOS and Android. It is important to note that a video game is a very complex piece of software because it requires interfaces for audio, image, and player interaction. Cocos2d-x helped to reduce the effort by including a diversity of modules for data storage, Artificial Intelligence, scripting, and several other required functionalities.

Game Mechanics

The content of the game included several processes linked to human societies (e.g. dispersion, adaptation, conflict, and cooperation). The player should be able to use and explore these topics through game mechanics. For this reason, it was decided

that *Evolving Planet* would be a strategy game. This decision would allow us to develop a game engine similar to current agent based models used in archaeology. The entire game would be based on a set of small duration missions. This progress dynamic was tailored to the type of short-term gaming typically seen on portable devices (Rubio-Campillo 2013). The player would control a population of agents within a dynamic landscape on each mission. The goals of the mission would be achieved by modifying traits on the level of the population instead of individual agents. This general structure would be flexible enough to create missions focused on particular processes or a combination of them.

As stated above, one of the major interests of the initiative was to explain how the scientific method is applied to understand past societies. The mission-based structure seemed perfect as each of the missions would be presented as a particular experiment designed to test a working hypothesis. Each mission would have a briefing explaining the context and making a question explicit: how could they survive in this zone? Did they move fast? How was their interaction with other species? These briefings explained the ideas of the xenoarchaeology team and how these would be validated against the results of the simulation experiment. This is, in fact, the method used in model-based archaeology to test a research hypothesis against the archaeological record.

To illustrate this approach, we highlight some prototypical missions:

1. We know that the population moved from point A to point B within a given time span. The player needs to replicate the time of arrival given by the existing evidence: if the agents arrive too early or too late to B then the experiment fails.

2. The group colonized a region previously populated by another species. Different hypotheses have been suggested for what their interactions looked like, so the player can try a diversity of strategies to pass the mission (i.e. violent conflict, hybridization, indirect competition).

3. There is evidence that the population used natural resources from a distant region. Possible explanations involve trade or conquest so the player should explore both ideas.

This structure also highlights the fact that sometimes hypotheses cannot be rejected due to the lack of enough evidence (i.e. equifinality). In addition, any scientific explanation is always subject to revision when new data appears. This idea is also reflected in the game structure as players can repeat a mission to improve their score. The devised game mechanics were flexible enough to present all these properties linked to the nature and dynamics of science.

Narrative

Strategy games can run the risk of distancing the player from the action. The player is not an on-screen agent, like as is the case in First-Person Shooters (FPS) or Role-Playing Games (RPGs). The genre mostly consists of top-down perspectives in which the player controls a large amount of indistinguishable characters (see for

Figure 10.1: Command console of Evolving Planet. A region of the planet is portrayed in the map, including geographical and environmental features. Population is depicted as coloured white dots. The player can indirectly interact with them by spending Evolution Points on their modifiable attribute (in this scenario: mobility, reproduction rate, and resistance) or temporarily boosting some of them. This user interface is rather similar to the ones used in agent based modelling.

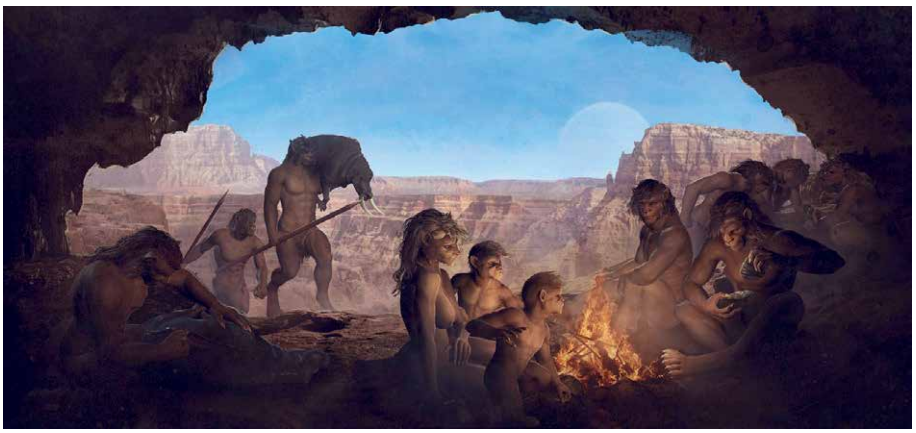

Figure 10.2: Sample of the illustrations unlocked by achieving mission goals. Here a hunter-gatherer domestic scene is portrayed. Despite the differences, several elements of the human past can be identified including fire, technology, food processing, and even social dynamics.

example the *Civilization* series, Microprose & Firaxis 1991-2016, and *Total War* franchise, Creative Assembly 2000-2016). This is useful for management but it has limits in terms of immersion. One of the current trends in strategy is complementing typical genre mechanics with RPG ideas designed to address this issue, such as personalization of characters (*X-COM*, Mythos Games *et al.*1994-2016) or the introduction of narrative elements (*The Banner Saga*, Stoic 2014).

Evolving Planet faced a similar challenge: the user interface would consist of a map with coloured dots representing the different populations (see Figure 10.1). The team decided to expand the original plot by adding a parallel narrative that would unfold over the 20 missions. After each successful experiment, the player would be provided with additional insight from the perspective of the replicated species. While the experiment briefings were based on short text descriptions and concise information, this parallel story was discovered through a set of high-quality illustrations accompanied by a window into the thoughts of and questions posed by the evolving species (see Figure 10.2). Each of the illustrations was thoroughly discussed to include state-of-the-art research hypotheses (e.g. Neanderthal-Sapiens hybridization). At the same time, the team tried to avoid common stereotypes of the past found in commercial video games such as predefined gender roles or the emphasis on social elites. In this way, we were able to tell the same story from two perspectives, that of the xenoarchaeologists and that of the sentient species, thereby increasing the engagement between the player and the controlled population.

The Challenge of Evolutionary Thinking

As exemplified by the title, evolution was one of the most important concepts for *Evolving Planet*. Evolutionary thinking is at the core of several archaeological simulations exploring topics as diverse as hominin dispersal (Romanowska 2015), cultural variation (Mesoudi & O'Brien 2008), social learning (Crema *et al.* 2014), or cooperation dynamics (Santos *et al.* 2015). The game roughly followed a trajectory spanning from the appearance of hominins to the Neolithic transition, combining ideas of both cultural and biological change. The importance of evolutionary dynamics could also be seen in the population-based approach: player interaction was based on the modification of adaptive traits in order to improve group fitness against different challenges.

The introduction of evolution proved to be extremely difficult. In our opinion, there is almost no video or board game in which evolution by natural selection is properly integrated into the mechanics. The reason is simple: real evolution is quite boring in terms of game design as it operates through random mutations instead of purposeful agency. In fact, any interaction between the player and her population should not be seen as evolution at work, but as a form of intelligent design. It does not matter if the player can affect the innovation path, learning, environment, or DNA: any change of selection mechanisms will be a manifestation of the player's ('God's') will. As a consequence, a large majority of games are not portraying Darwinian evolution but a flavour of Creationism such as intelligent design. Due to the randomness of mutation mechanisms, natural selection also implies non-predictability. In contrast, most games have a predefined pool of potential innovations (see for example *Plague Inc.*, Ndemic Creations 2012, for biological change and the *Civilization* franchise for cultural change). As a consequence, games portraying evolution are essentially showing a narrative of progress guided by the decisions of supernatural entities such as the player or the designers. It is worth noting that these limits on the narrative of video games have been explored by some games such as *The Stanley Parable* (Galactic Cafe 2013) or, more recently, *Inside* (Playdead 2016).

How, then, can we integrate evolution in a video game if any interactive game mechanic is breaking the concept of evolution itself? The development team tackled this challenge with multiple decisions. First, we discarded a pure evolutionary mechanism and decided to create a story that would explicitly integrate intelligent design. In contrast with games like *Plague Inc*. or *Civilization*, the player would not be interacting with a natural context but with a large-scale laboratory. She would take the role of the scientist controlling a population of androids created by humans through artificial selection. In this way we avoided the paradox of interacting with a purely evolutionary system led by natural selection. At the same time we wanted to show how natural selection will interfere with any artificial selection process. We introduced this concept using a narrative device: as the missions progress the player will feel that control over the population decreases over time, peaking in the different endings of the game.

We also avoided linearity by designing missions with multiple solutions. The population would achieve its goals by different means, from specializing on some strategy to increasing its reproductive rate or attacking competitors. Contrary to most games, the adaptations of the species would not accumulate from one mission to the other. In this way we wanted to show that fitness is an ever-changing concept as it is strictly linked to present environmental conditions: a species with high fitness in one scenario can become extinct if its environment changes. As a consequence, the populations of the later missions would not have increased reproductive or movement rates compared to the first ones.

Finally, achievements would be unlocked based on the player's performance. They provide small tokens of scientific knowledge linked to the goals of each mission. A large percentage of them promote evolutionary thinking, from the famous tree of life drawn by Charles Darwin to quotes by famous scientific communicators on topics such as intelligent design and biological evolution. In this way, the project tried to improve the understanding of evolution via multiple routes while relying on thoroughly tested design mechanisms. It remains a challenge for future projects to create an interesting video game using evolution by natural selection as its main game mechanic.

Release and Impact

After being in development for almost 2 years, including an extensive beta testing phase, *Evolving Planet* was successfully released for iOS and Android platforms in early 2016. The impact of the project exceeded the team's expectations, despite the limited resources and the lack of advertising budget. The game has been downloaded over 40.000 times in 1 year. Beyond quantitative measurements, the team also got feedback from persons with a diversity of profiles, including hardcore gamers, high school teachers, and archaeologists (see *e.g.* Graham 2016).

This experience supports the idea that video games are one of the best available methods for explaining the past (Metzger & Paxton 2016). The combination of powerful narrative and problem solving makes them particularly well adapted to translate the dynamics of archaeological research (Meyers Emery & Reinhard 2015). They can provide a rich perspective on the past while avoiding the linearity and determinism of other media such as books or documentaries. It

is also remarkable that players are active users who need to download and play the game. Their interactivity and ability to craft experiences for individuals on a massive scale gives video games an edge over other mass media such as television or newspapers (Skoric *et al.* 2009). Finally, the new distribution systems and open-source development platforms have decreased the budget required to create a video game up to the point where initiatives linked to research can actually compete with the rest of the market.

Video games are frequently judged negatively in terms of education. Scholars have been so focused on analysing whether they can affect social and individual behaviour, that we often ignore their potential benefits (Squire 2003). As researchers, part of our job is to explain what we do to the rest of society, and video games can be an excellent tool to achieve this goal.

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The game is freely available for iOS and Android devices at <www.evoplanetgame.com>. Source code has also been released under a GPL license and can be downloaded from GitHub.

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The Stanley Parable. 2013. Galactic Cafe. Galactic Cafe. [PC, MAC and Linux]

Star Wars Knights of the Old Republic II: *The Sith Lords*. 2004. Obsidian Entertainment. LucasArts & Aspyr. [Xbox, PC, MAC and Linux]

Tomb Raider series. Core Design & Crystal Dynamics. Eidos Interactive & Square Enix. [multiple platforms]

Total War series. 2000-2016. Creative Assembly. Electronic Arts, Activision & Sega. [PC and MAC]

Uncharted series. 2007-2016. Naughty Dog. Sony Interactive Entertainment. [PlayStation 3 and PlayStation 4]

X-COM series. 1994-2016. Mythos Games, MicroProse, Hasbro Interactive, Infogrames, Irrational Games, 2K Marin & Firaxis Games. Microprose, Hasbro Interactive, Infogrames & 2K Games. [multiple platforms]

THE INTERACTIVE PAST

Video games, even though they are one of the present's quintessential media and cultural forms, also have a surprising and many-sided relation with the past. From seminal series like *Sid Meier's Civilization* or *Assassin's Creed* to innovative indies like *Never Alone* and *Herald*, games have integrated heritages and histories as key components of their design, narrative, and play. This has allowed hundreds of millions of people to experience humanity's diverse heritage through the thrill of interactive and playful discovery, exploration, and (re-)creation. Just as video games have embraced the past, games themselves are also emerging as an exciting new field of inquiry in disciplines that study the past. Games and other interactive media are not only becoming more and more important as tools for knowledge dissemination and heritage communication, but they also provide a creative space for theoretical and methodological innovations.

The Interactive Past brings together a diverse group of thinkers — including archaeologists, heritage scholars, game creators, conservators and more — who explore the interface of video games and the past in a series of unique and engaging writings. They address such topics as how thinking about and creating games can inform on archaeological method and theory, how to leverage games for the communication of powerful and positive narratives, how games can be studied archaeologically and the challenges they present in terms of conservation, and why the deaths of virtual Romans and the treatment of video game chickens matters. The book also includes a crowd-sourced chapter in the form of a question-chain-game, written by the Kickstarter backers whose donations made this book possible. Together, these exciting and enlightening examples provide a convincing case for how interactive play can power the experience of the past and vice versa.

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